



# Prediction of Traffic flow in some selected corridors within Akure South Local Government using Scaled Conjugate Gradient Neural Network

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## General Note

 Article is recommended to print as color digital version in recycled paper.

## ABSTRACT

Accurate traffic flow prediction is one of the various ways of decongesting vehicular activities associated with urbanization. As a growing city, Akure south Local Government Area (LGA) metropolis is faced with the challenge of increasing vehicular movement. In this paper an attempt is made in predicting traffic flow using scaled conjugate gradient neural networks to model the traffic data. The traffic data was collected November 2018 to April 2019 (a period of six months) in the selected corridors by using manual traffic count and video camera. The data was processed using Matlab R2015a toolbox. The predicted data were increased by 2% and the

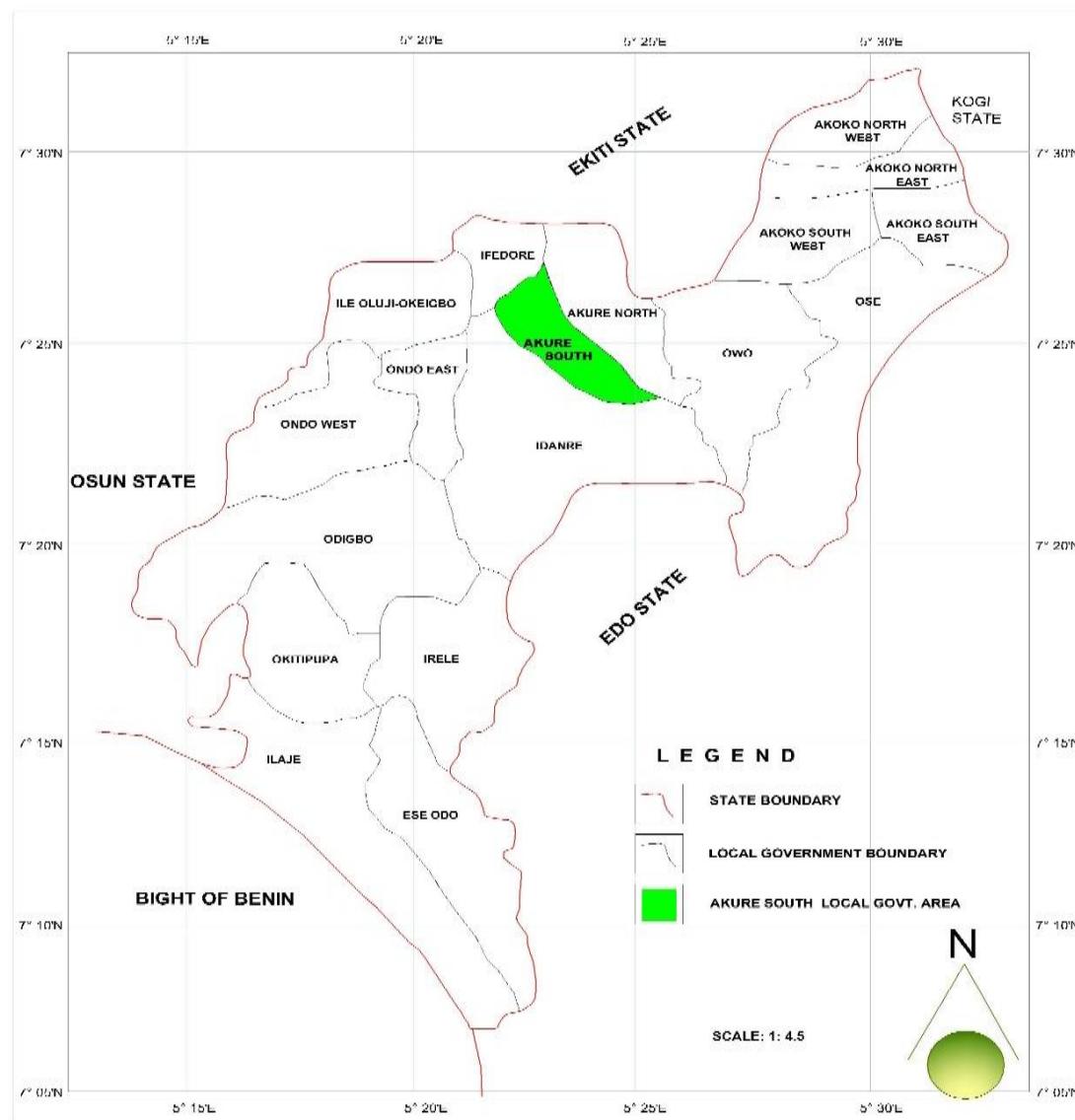
corresponding output analyzed. Scaled conjugate gradient neural network gave encouraging results in predicting the traffic flow in the selected areas of interest.

**Keywords:** Traffic flow, Prediction, scaled conjugate gradient Neural Networks.

## 1. INTRODUCTION

Traffic situation in the city of Akure south Local Government Area (LGA), Ondo state, located south western Nigeria has been on the increase. This is a major concern for everyone as it affect human activities and their well-being.

The study area lies on latitude  $7^{\circ} 4'$  and  $70^{\circ} 25'$  north of the equator and longitude  $5^{\circ} 5'$   $5^{\circ} 30'$  east of the Greenwich meridian. The study area is a medium sized metropolis in Nigeria judged by its tremendous rate of population growth. Akure south LGA is situated 250 metres above sea Level. It is surrounded by large granite formations of volcanic origins. Akure south LGA is in the humid tropical region of Nigeria, with an annual rainfall of over 1500 millimetres. During the months of December, January and February the cooler dry continental air from the north-east prevails. Traffic congestion in Akure south LGA has increased greatly with the introduction of new vehicles into the city every week. Figure 1, is the map of Ondo state were the study was carried out. There has been no known work on predicting the traffic flow situation in Akure south LGA, a problem prevalent in Nigeria as a country. Hence, the prediction of traffic flow at some intersections is important for adequate planning for road users.



**Figure 1:** map of Ondo state showing Akure south Local Government Area (LGA).

This study aims at the prediction of the traffic flow volume based on traffic data in each of the selected corridors. The prediction model is based on scaled conjugate gradient neural networks.

A lot of scientists have been encouraged to try artificial neural network simulators techniques in solving complex analytical problems. It is therefore important to recognize what neural networks are capable of doing and when their application may perhaps lead to new results that are otherwise difficult to achieve with standard methods. The much interest shown by scientists in neural networks started from the practical as well as theoretical approach taken in the application of the network. A neural network is an artificial demonstration of the human brain that tries to mimic its learning process (Chakraborty, 2010). The input, hidden and output layers forms the building blocks of neurons in ANN (Haykin, 1999). Neural networks algorithm offers new architectural ideals for computing machines and new approaches for learning. However, the advancement of the understanding of the nervous system is the most important objective of neural network investigation. The ability of neural network to convert non-linear and complex statistical representations into simple forms makes it a handy tool for data analysts (Odesanya, 2019). Neural networks are now being routinely used in the process control, manufacturing, quality control, product design, financial analysis, fraud detection, loan approval, voice and hand writing recognition, and data mining (Poulton, 2001). It also of interest in the transportation sector as a lot of researchers have been considering the application of neural network in predicting and analyzing traffic volume in major cities around the world (Faghri and Hua, 1992).

## 2. MATERIALS AND METHOD

The traffic data used in this work was collected manually and with the aid of video recording along the selected corridor. The considered data set covers a period of six (6) months from November 2018 to April 2019.

The road network selected was considered because of their high traffic flow they are known for during peak hours. The National Cooperative Highway Research Program (NCHRP, 2010) requires that collection of traffic flow be at peak period because those are the traffic data (peak hour) that are required for measuring vehicular flow. The traffic data collected indicated the existing peak hour of traffic conditions of the route chosen. Data were obtained between the hours of 7.00 am - 9.00am (morning peak), 11 am – 1 pm (Afternoon session), and 3.00 pm - 5.00pm (evening peak). The morning session and evening session reflects the peak hour for human traffic and various commercial businesses. Data collection techniques such as video recording and field observation were used in the data collection.

### Video Recording Method

Video recordings of the selected point along the corridor were carried out for 6 months to be able to get a fair movement within the corridor. This was achieved by placing a video camera on a tripod stand close to the under studied selected point along each of the selected corridor followed by manual extractions of the vehicular flow. The video was played over and over again to extract the inflow from each lag at the entry point. The traffic flow of bicycles, tricycles, motorcycles, cars, buses and articulated vehicles in the data sheet designed. A similar method was also carried out by (Odesanya, 2020).

### Field Observation method

Eight trained undergraduate field observers, were paid to collect data at each lane of the selected corridor for a period of six (6) weeks to be able to get a fair movement within the corridors and the point on the corridor selected for the analysis, while two (2) observers each were placed per lane, one person was responsible for the entry traffic flow while the other person was responsible for booking the data along the selected point. Manually, these trained observers carefully count and input data of the traffic flow of bicycles, tricycles, motorcycles, cars, buses and articulated vehicles in the data sheet designed for the purpose of the study and records were for real time traffic flow.

Traffic flow  $Q_e$  is later converted to Passenger car unit per hour (pcu/h),

Where

$Q_e$  = Entry Flow

Pcu/h = Passenger car unit per hour.

The conversion is taken based on Mauro (2010), thus:

1 motorcycle = 0.5 pcu;

1 bicycle = 0.5 pcu

1 truck or bus = 1.5 pcu;

1 truck + trailer = 2.0 pcu;

Peak Hour Factor (PHF) is a process for adjusting the variability of demand throughout the peak hour conversion for traffic flow and this is used for this study. The selected corridor consists of three points each were within Akure South LGA metropolis as shown in figure 2.

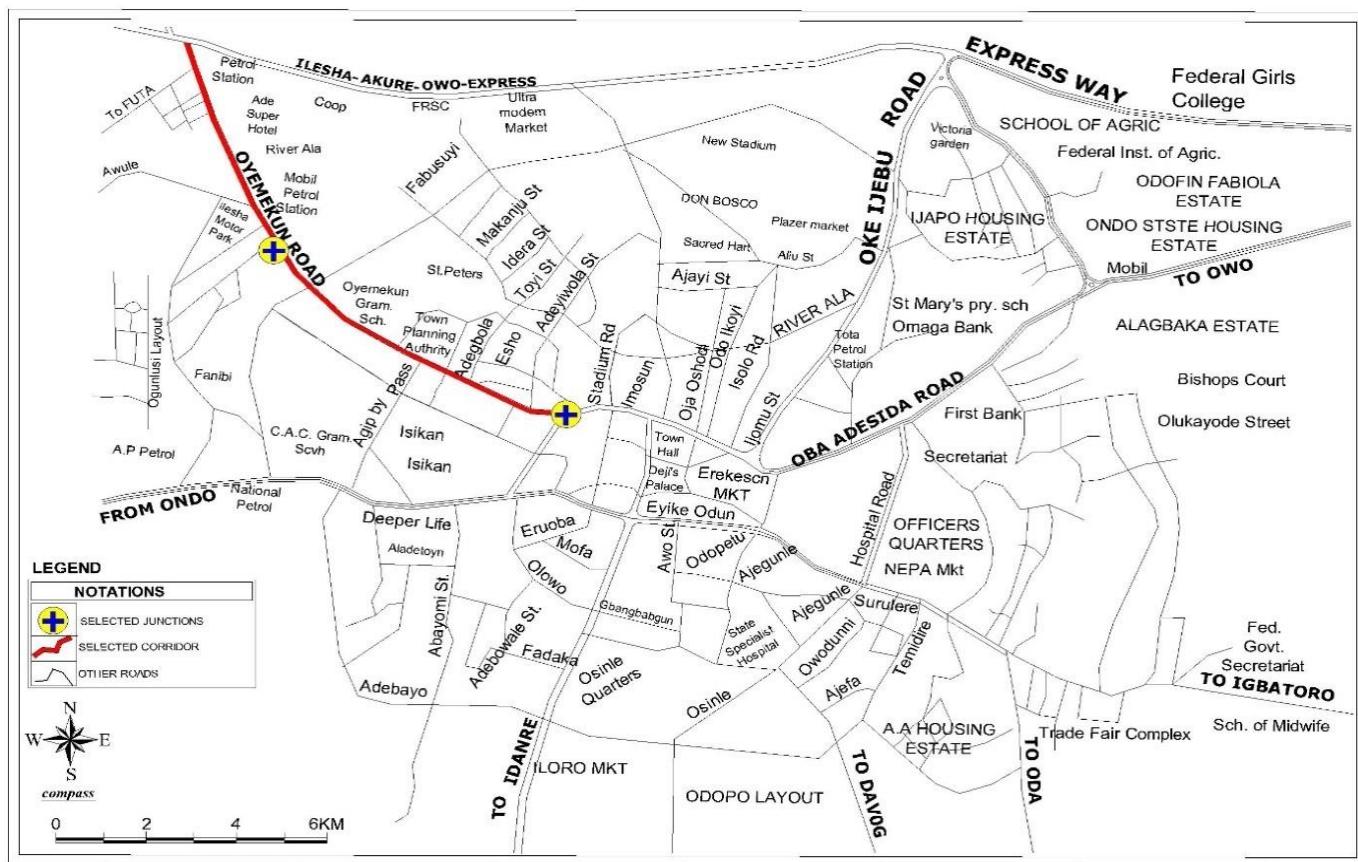


Figure 2: Akure Network of Road Showing Network of Selected Road Corridors.

The road network system in Akure South LGA comprises both earth road in some areas, surface dress road which usually serves as connector to sub-arterial road, and asphaltic concrete roads which are mostly the arterial road that connect streets to other towns in the state and by extension other state and urban centre in Nigeria. As of 2011, Akure south LGA has 230.1 km of bitumen road and 233.9 km untarred road with over 800,000 automobile as at (Ondo State Government, 2012; Oyedepo and Afolayan, 2016).

Neural network model with scaled conjugate gradient algorithm was used in this study to predict the traffic flow of the selected corridors. The scaled conjugate gradient algorithm is chosen because of its ability to learn fast in a supervised neural network. Most methods employed for optimization are based on minimizing the local iteration processes, in which function approximation is in a neighborhood of points currently in weight space for minimization. The algorithm which minimize error function  $E(w)$ . Can be as represented below;

The initial weight vector  $w_I$  is chosen and set  $k = 1$ .

The search direction  $p_k$  is determined and a step size  $\alpha_k$  such that,  $E(w_k + \alpha_k p_k) < E(w_k)$ . The update vector:  $w_{k+1} = w_k + \alpha_k p_k$ .

Now, if  $E(w_k) \neq 0$  then set  $k = k + 1$  and go to 2 else return  $w_{k+1}$  as the required minimum.

If  $p_k$  in the pseudo algorithm above is negative, that is,  $-E'(w)$  and  $\alpha_k$  is set to a constant  $\epsilon$ , this process becomes the gradient descent algorithm (Gill *et al.*, 1980). The scaled conjugate gradient algorithm is represented in equations (1) and (2).

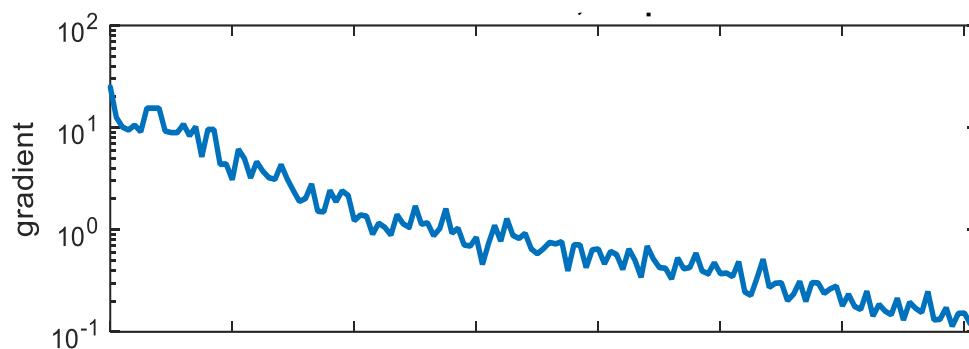
$$s_k = E''(w_k)p_k \quad (1)$$

The scaled conjugate gradient algorithm is basically another approach in estimating the step size in a function. The aim here, is to estimate  $s_k$  in conjugate gradient with an approximation that is non symmetric in nature. Hence, equation (1) approximates to equation (2)

$$s_k \approx \frac{E'(w_k + \partial_k p_k) - E'(w_k)}{\partial_k}. \quad 0 < \partial_k \ll 1 \quad (2)$$

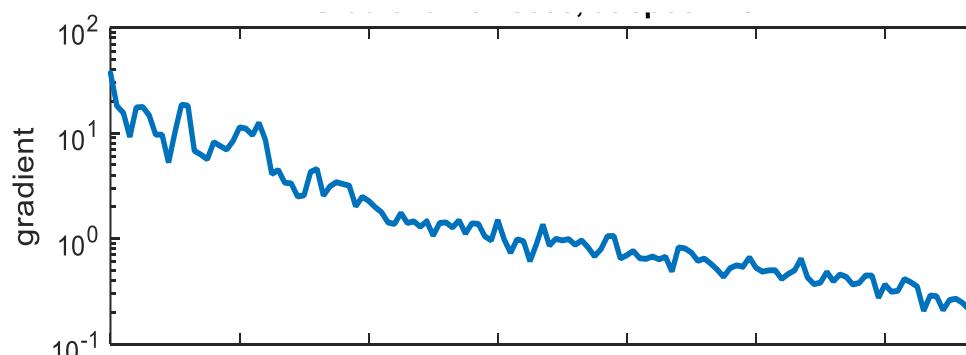
Where  $\partial_k$  is the step size in conjugate gradient.

The network was trained using the preprocessed traffic count data which serves as the input data. Since scaled conjugate gradient is a supervised neural network, targets were set based on the raw traffic data collected. Both the preprocessed and target data were fed into the network. The network consists of a two-layer feed forward network with ten hidden weight neurons using trainscg as the training function. The training stopped when the validation check was completed in 142 number of iterations at a gradient of 0.209 as presented in figure 3.



**Figure 3** gradient section of the trained traffic data.

The output of the network was increased by two percent (2%) and analyzed, the aim of increasing the output by a little percentage was to predict the future traffic flow volumes in the selected corridors. This time, the initial target and weights remains unchanged. The training stopped when the validation check was completed in 134 number of iterations at a gradient of 0.250 as presented in figure 4.

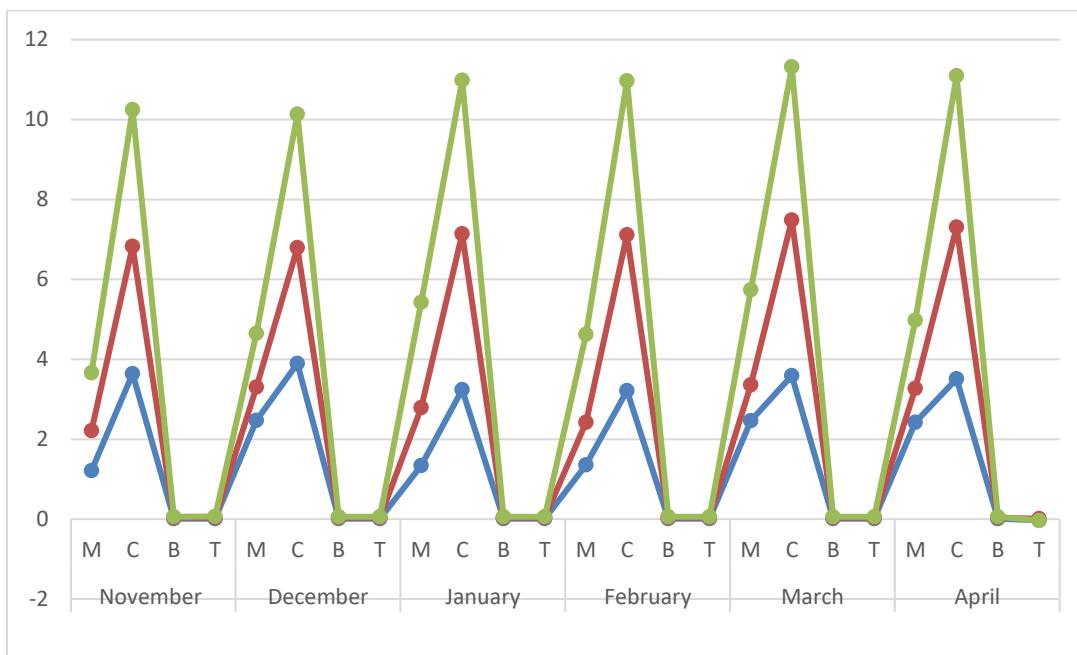


**Figure 4:** gradient section of the increased traffic data.

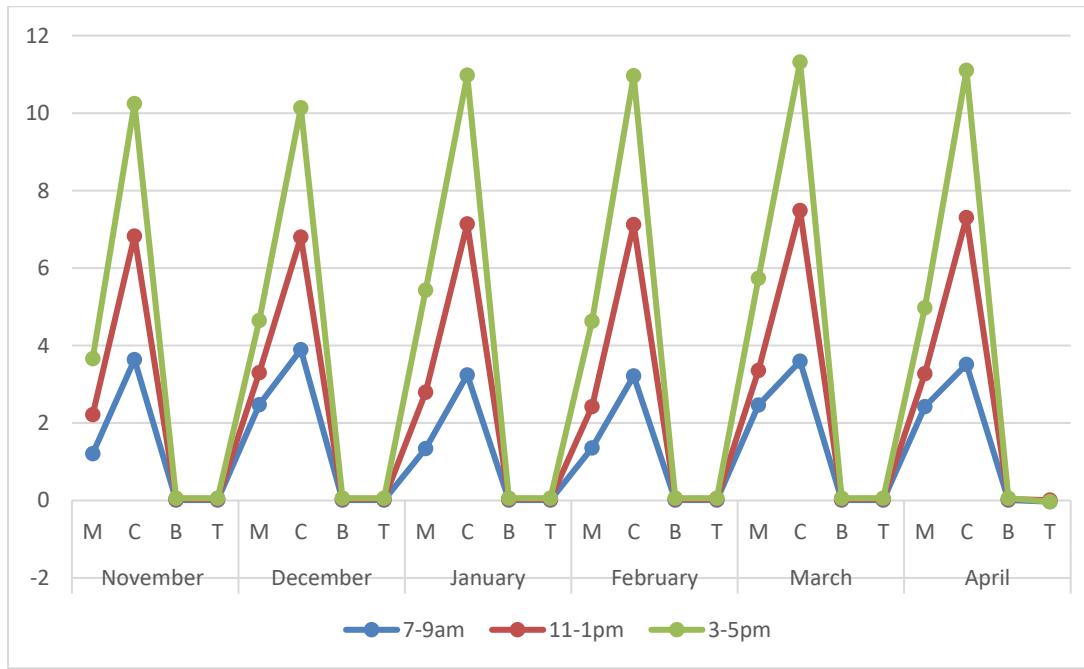
### 3. RESULT AND DISCUSSION

The scaled conjugate gradient neural network training of the traffic data converged within 142 epochs in less than a minute. From the result, Figure 5 and figure 6 present the traffic flow of cathedral junction along Oyemekun road and the predicted output respectively. Figure 5 shows that the scaled conjugate gradient neural network training of the traffic data when no increase was witnessed from November 2018 to April 2019. However, with a 2% increase in the traffic flow of motorcycles (M), Cars (C), Buses (B)

and Trucks (T) in figure 6, The scaled conjugate gradient neural network training of the traffic data shows virtually no much different from what is obtainable when the traffic stream was not increased meaning that, that road junction could very well accommodate more traffic flow without traffic bottle neck being witness along the road corridor.

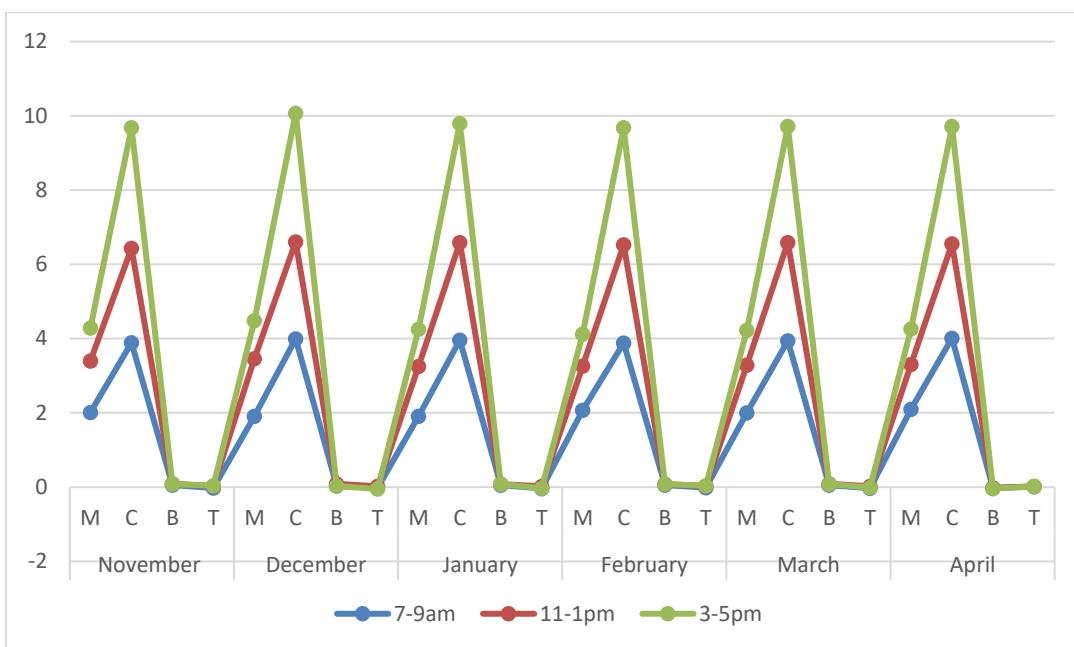


**Figure 5:** Cathedral junction traffic flow (2018-2019).

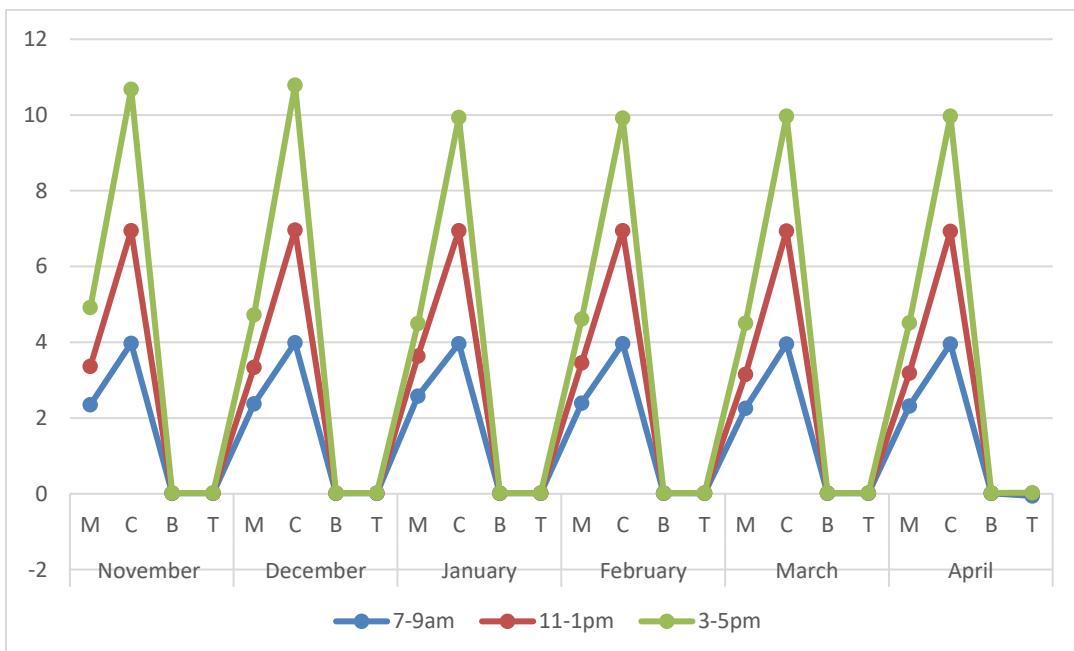


**Figure 6:** Predicted Cathedral junction traffic flow (2018-2019).

However, Figure 7 and figure 8 present the traffic flow of Ilesha junction and the predicted output respectively. Figure 7 shows that the scaled conjugate gradient neural network training of the traffic data when no increase was witnessed from traffic stream in Ilesha garage junction from November 2018 to April 2019. However, with a 2% increase in the traffic flow of motorcycles (M), Cars (C), Buses (B) and Trucks (T) in figure 8. The scaled conjugate gradient neural network training of the traffic data shows a gradual raise in the traffic flow. From the result obtainable, it shows that any slight increase in the traffic stream at this junction will cause an increase stress on the existing road furniture. This increased stress on the road junction could cause congestion on that corridor.



**Figure 7:** Ilesha garage traffic flow (2018-2019)



**Figure 8:** Predicted Ilesha garage traffic flow (2018-2019).

#### 4. CONCLUSION

The aim of this paper was to predict traffic flow using the scaled conjugate gradient neural network on traffic flow data collected in some selected corridors in Akure South local Government, Ondo State. Scaled conjugate gradient neural network has successfully predicted the behavioral tendency that could be witnessed on a road junction with sight increase in traffic stream along such corridor. It has showed the network is a good predictive tool for traffic data during peak periods and even off peak periods.

#### Authors' contribution

Data collection J.F.Odesanya

Methodology, J.F Odesanya and I. Odesanya;

Writing-Review, J.F Odesanya and I. Odesanya;

Neural network analysis. I. Odesanya.

Editing, J.F.Odesanya.

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**Conflict of Interest:**

The authors declare that there are no conflicts of interests.

**Peer-review:**

External peer-review was done through double-blind method.

**Data and materials availability:**

All data associated with this study are present in the paper.

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